



Cobra Invitational, Birmingham Covington School  
Wind Power Test  
Division B  
January 30, 2016

Names: \_\_\_\_\_

Team Name and #: \_\_\_\_\_

Score

**Directions: provide the *best* answer to each of the questions below. Show all work and use relevant units where applicable. All questions are worth 1 point each unless otherwise indicated. There is a total of 50 possible points on this test.**

1. Which of the following does not function as a primary energy source?
  - a. biomass
  - b. natural gas
  - c. solar
  - d. electricity
  - e. geothermal
2. Explain briefly what distinguishes a primary energy source from a secondary energy source:  
(2 points)
3. Which of these energy sources produces the lowest level of CO<sub>2</sub> emissions during power generation?
  - a. biofuel
  - b. coal
  - c. photovoltaic panels
  - d. propane
  - e. natural gas
4. Which of the following is **not** a concern some have regarding wind energy?
  - a. It has a negative impact on the visual appeal of a landscape.
  - b. It threatens birds whose migratory pathways take them through areas where wind farms are located.
  - c. It is a nonrenewable energy source.
  - d. It creates dangerous levels of electricity in storms and other times of high winds.

**Read the following statements regarding the process of transmitting electricity from a power plant, and then answer the questions that follow.**

1. *Electricity is carried to homes and businesses.*
  2. *Electricity is sent on a network of distribution lines.*
  3. *Electricity travels to a step-down transformer at a substation.*
  4. *Electricity is generated at a power plant.*
  5. *Electricity travels by wire to a step-up transformer.*
5. What is the correct sequence of steps in this process? Write the corresponding numbers for the steps in proper order:  
(3 points)

\_\_\_\_\_

6. Which of the following choices best describes what a transformer does?

- a. It increases the voltage of the electricity passing through it to reduce losses over power transmission lines.
- b. It reduces the voltage of the electricity passing through it to reduce losses over power transmission lines.
- c. It transforms the current of the electricity into voltage so that it may be safely transmitted from place to place.
- d. It reduces the voltage of the electricity passing through it so that household appliances can use it.
- e. Both a and d are correct
- f. Both b and c are correct.

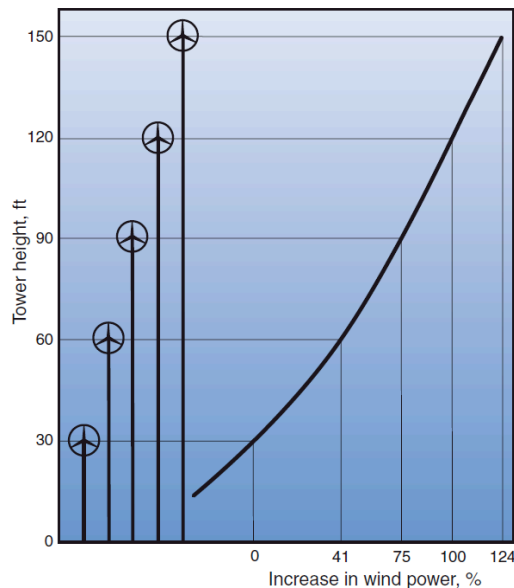
**Read the following statements carefully. Circle whether each statement is either TRUE or FALSE.**

7.	DC, or direct current, describes the flow of electric charge that changes direction periodically.	TRUE	FALSE
8.	Electric power supplied to houses and businesses is almost always in the form of AC, or alternating current.	TRUE	FALSE
9.	Batteries and photovoltaic cells supply AC.	TRUE	FALSE
10.	Thanks to Thomas Edison, the United States has always used AC to supply electricity to homes and other consumers.	TRUE	FALSE
11.	Thanks to George Westinghouse, AC was introduced as a way to supply homes with electricity even if they were many miles from a power plant.	TRUE	FALSE
12.	An advantage of DC over AC is that it can be transported over great distances with less loss of energy.	TRUE	FALSE

**For Questions 13-16, read the following four statements about the design advantages of either Horizontal Axis Wind Turbines (HAWT) or Vertical Axis Wind Turbines (VAWT). In the space provided, put a checkmark indicating which wind turbine type demonstrates this advantage.**

	HAWT	VAWT
13. Increased access to higher wind energy.	<input type="checkbox"/>	<input type="checkbox"/>
14. Decreased visual impact on landscapes.	<input type="checkbox"/>	<input type="checkbox"/>
15. Easier to perform maintenance.	<input type="checkbox"/>	<input type="checkbox"/>
16. Increased efficiency.	<input type="checkbox"/>	<input type="checkbox"/>

Use the graph below to answer Questions 17 and 18.



17. Based on the graph above, which of the following statements may be concluded?
  - a. Wind power decreases as tower height increases.
  - b. A tower that is 90 feet tall generates the most power.
  - c. A tower that is 120 feet tall has twice as much wind power available to it than one that is only 30 feet tall.
  - d. Above a certain height, increasing the tower height does not affect the wind power available.
  
18. Based on your understanding of wind energy, the relationship depicted on the graph above is a result of the following scientific phenomenon:
  - a. Vertical axis wind turbines are more efficient.
  - b. Wind travels faster, and thus transmits more power, at higher distances above ground.
  - c. The greater the area swept by the rotor blades, the higher the power generated by a wind turbine.
  - d. Air density increases at greater heights, thus transmitting more power.
  
19. For power generation, many commercial wind turbines have 3 blades, while some have two. Explain one advantage of a 2 blade wind turbine, and one advantage of a 3 blade wind turbine. (4 points)

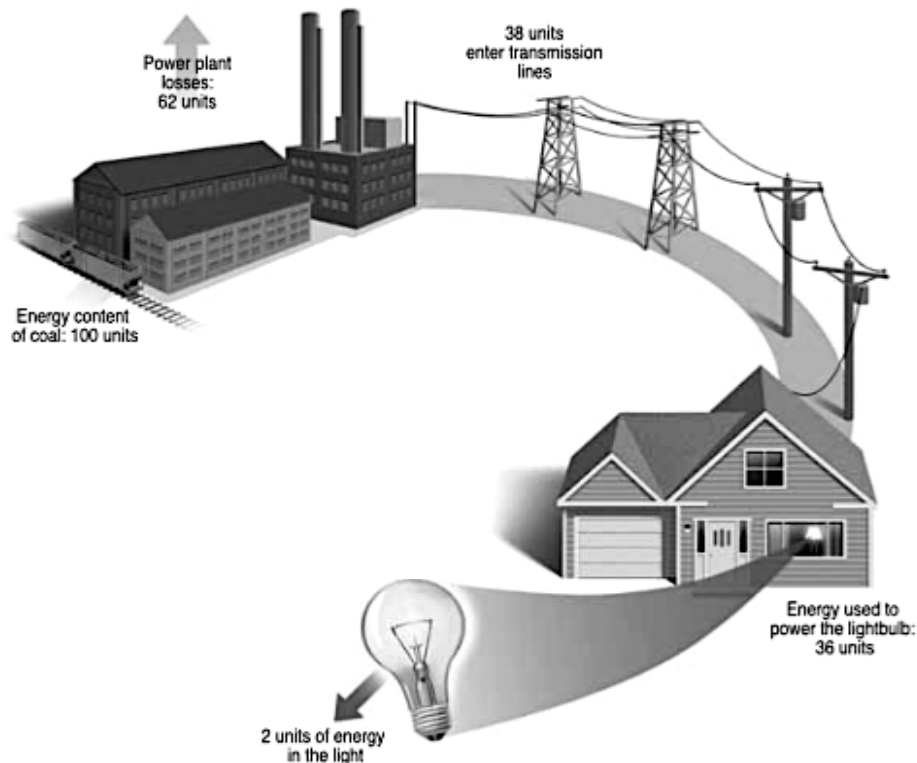
20. How much power is available to a 3 blade wind turbine with 5 m blades, if the wind velocity is 6 m/s, and the air density is  $1.1 \text{ kg/m}^3$ ? Show all work below, and include relevant equations and units. (3 points)
21. Now that you have calculated how much power *is available to* this particular wind turbine at this wind velocity, use your result from the previous question to determine the theoretical maximum power that it can *generate*. Show all work below, and include relevant equations and units. (3 points)
22. If this wind turbine produces 120 V and 15 amps at this wind speed, calculate:
- The power it is generating (2 points)
  - Its coefficient of power ( $C_p$ ) (2 points)
23. Why is power storage important when considering “green” (low emissions/renewable) energy sources?  
(3 points)
24. Provide one example of power storage for each energy type listed below:  
(3 points)

Mechanical:

Chemical:

Thermal:

Use the diagram below to answer Questions 25-28



25. Calculate the efficiency of the coal power plant. Include any relevant equations and/or units.  
(2 points)
26. What percentage of the original coal energy is actually transmitted as light?  
(2 points)
27. Aside from the power plant loss, what is the next largest source of energy loss in the lighting of the incandescent light bulb? Why is this?  
(2 points)
28. Explain one alternate strategy to improve the overall efficiency in the process of lighting one's home.  
(2 points)